DOI: 10.21005/pif.2020.43.B-01

AN INTRODUCTION TO THE DESIGN OF INNOVATION PARKS

Golamali Kazemi Lary
Post graduate candidate of architecture
Author's Orcid number: 0000-0002-4094-073X

Academic Department of Architectural design of civil buildings and constructions
Kiyv National University of Construction and Architecture, Kiyv, Ukraine

ABSTRACT

This article deals with the categorizing of Innovation Park's structure. Such developments are considered to be carried out based on a systematic approach to solve issues of the architectural organization. Innovation Parks are classified into three groups: small, medium, large and giant. Consequently, the article proposes schematic planning decisions for these principal forms of Innovation Parks.

Key words: Innovation Park, business incubator, innovation center, mono & multifunctional enterprises, unidisciplinary (non-diversified) & multidisciplinary center, functional group, functional unit.

1. TERMINOLOGY AND DEFINITIONS

It is necessary to determine some terms for more appropriate comprehension of this article.

Innovation Park – even though the term "Science Park" is used as a common name, it is necessary to remind that some Science Parks are not specialized for scientific researches. In this respect, depending on the focus of technology park's activities, there are several terms as "Innovation Center", Industrial Hotel", "Industrial Park", "Commercial Park", "Eco Park", "Science Park", "Technology Park" or combination of some of them like "Science and Technology Park". Therefore, it will be more correct to use the term "Innovation Park" (briefly IP). The IP is an open system that is formed to connect science, education, industry and trade. This is a common name for varieties of innovative institutions and spaces, both independent and dependent on other enterprises. This structure summarizes a wide range of innovative enterprises, ranging from a business incubator to a science and technology region (Lyashenko, 2013, 19). The goal of IP is to accelerate the industrialization and commercialization of new technologies. Every IP includes spaces or buildings to place innovative companies. Such spaces and buildings are named as business incubators. Business incubator can be considered as a structure specializing in creating favorable conditions for the emergence of effective activities of small innovative (venture) firms that implement original scientific and technical ideas. This is achieved by provision of material (scientific equipment and facilities), information, consulting and other necessary services (Pugina, 2012, 54).

Innovation Center - is a small enterprise and the simplest form of IP, which is organized as a business incubator. It is mainly an urban building.

Industrial hotel – buildings, which are designed to rent out for temporary use to an unknown client, engaged in innovative activities. The possibility of multi-purpose use and universality is laid in the planning and engineering solution of these objects (Khrustalyov, 2011, 5) (Diakonova 2016, 21).

Business incubator - a business incubator is considered as a structure specializing in creating favorable conditions for the emergence of effective activities of small innovative (venture) companies that implement original scientific and technical ideas. This is achieved by providing small innovative firms with material (scientific equipment and facilities), information, consulting and other necessary services (Pugina, 2012, 54). From an architectural point of view, business incubators are mainly universal offices with flexible planning solutions. They may also include laboratory facilities, meeting and conference rooms. However, as we will see later in the innovation park, these functions can be separated from each other. The global demand for innovative parks aimed at increasing the share of business incubators is increasing. Today, only in the UK there are more than 800 new parks with a total area of over 30 million square meter (m^2), most of which is intended for equity participation of teams of risky business activities - short or medium term (Khrustalyov, 2011, 2). Business incubators can be divided into two main types. The first includes those that act as independent organizations. The second includes incubators that are part of techno-narcotic structures (Rumyancev, 2006, 29).

Functional group – as there are several functional zones in an IP, it is necessary to separate them to simplify their functional processes, future expansions and transformations, and to comply with sanitary norms and rules. From this point of view, it is possible to have office, social, special, scientific, production, and technical service functional groups. The business incubators, directory and administrative offices can be organized in one functional group. The first step facilities of common ware (conference halls, amphitheater) form the special group. The secondary facilities of common wares (café, restaurant, sport hall, library, and exhibition, recreating spaces and so on) create the social group. Laboratories, experimental halls, workshops and research facilities, all should be in scientific group. Eventually all spaces with industrial character (production halls, warehouses, workshops of repair and invention of machines and instruments workshops) must be located in production group.

Functional unit – depend on size and structural necessity, some elements of one, two or three functional groups can be located in one set. For example, elements of office, social and special functional groups can be gathered in one business incubator unit to create a more comfortable situation for companies. In the same way, some offices, meeting rooms and recreating spaces are needed

in production or laboratory units. It means that to have pure functional groups is impossible, however we can manage the organization of functional zones in separate units.

2. INTRODUCTION

The general method of a research for architectural design of IP is formed based on complex functional and structural analysis. This method includes field examination, statistical analysis, and analysis of influence factors, graphic analysis of initial data, structural functional-spatial modeling, conceptual design, and economic analysis by criteria of expediency of choosing IPs' directions and scale, the space-planning solution of the IP in accordance with territorial characteristics.

By the method of field examination, computer modeling, statistical analysis of electronic and literary sources, the data about content architectural and planning organization are classified on the composition, design and planning organization. Author of this article proposes conceptual schemes for IPs with various territorial categories due to studying specialization and technical condition of existing analogs in world practice which allows establishing the functional composition, volume-planning structure, constructive basis, engineering and architectural features of objects.

There are several factors which influence the IPs' formation such as Socio-economic, urban planning, natural & climatic, sanitary & hygienic, technical, and operational factors. Socio-economic factors should be divided into two groups: human source organization factors; monetary and non-monetary funds. These factors are important not only in the formation, but also in survive, transformation, scale and the scope of its IPs activities. The population size affects IP's formation, as the activity of an IP depends on the availability of specialists (scientists, engineers and workers), the relationship with other canons of innovation, the information exchange, and formal / informal meetings of employees inside / outside the enterprise. This influence is mutual, since the presence of IP entails an increase in the population, and provides a favorable working and residential environment. In addition to human resources, private and public sector investment, political and legal foundations are also important factors for IP formation.

Urban factors include the formation of urban agglomerations around large cities, which are places of scientific institutions' concentration (Lilueva, 2011, 70-82). IP's integration in urban development is revealed by the building density and territorial capability. Density is the ratio of the built-up area to the area of the total territory. The building density of an IP depends on the sphere of the activity, standards, topographic characteristics of the area and the stage of its development. UN-Habitat advises 15000 inhabitants/ Kilometer square – km^2), but in some cases lower densities, such as 5000 inhabitants/ Km^2) can be chosen if this fits better with the local context (Guidelines for urban planning, 2016, 15).

In the design of IP, foreseeing the place of industrial enterprises and their further growth is of particular importance. The size of sites for industrial enterprises range from 1 to 600 hectare (ha). However, sites of 1000 hectares and more should be reserved for group accommodation of large industrial enterprises (Belousov, 1978, 31). Enterprises which are active in industrial and agricultural sectors are mainly formed within the metropolitan areas. It is necessary to collocate scientific centers with them. Scientific centers dealing with fundamental sciences should be accessible for several industrial enterprises, and those which engaged in a special research must be placed near the according industrial zone or integrated into it (Saveliev, 1977, 14-17). An IP can organize scientific and industrial zones by housing them. It is advisable to ensure that as a result of the planning and development of industrial areas, industrial enterprises and related facilities occupy at least 50-60% of the total area of an industrial district. However, it is necessary to pay attention to this fact that an excessive increase in the number of enterprises, their capacity or building density can negatively affect sanitary conditions, increase the concentration of industrial hazards, and complicate the organization of traffic. Therefore, it is important to determine the optimal size of industrial areas, taking into account progressive regulatory indicators of the enterprises' density, the total number of workers and relations with other areas of the city (Sysoeva, 2005, 30). Another criteria of industry accented IPs is the organization of separate closed public service networks for industrial units and

districts. These networks can reach 80% of total public service networks of an IP in form of an industrial city (Yezhov, 2006, 21).

An IP can be formed in several ways: integration, reconstruction, association, completely designing in advance. The business incubators as the main elements of an IP can be integrated in campuses and gradually convert them to university based IPs. As industrial enterprises have appropriate infrastructure and large territories which are structured in most cases, can be reconstructed to IPs. Some innovative enterprises (institutes, research centers, fabrics, business centers) which are concentrated in a place, associate and form an IP. According to a report by the Brookings Institution outline common forms of IPs are: 1. the anchor plus model centered on a university (within the campus); 2. The re-imagined urban areas (e.g. a disused waterfront industrial area); and 3. The urbanized science park (a redesign of the auto-dependent, single use, suburban tech park) (Birch, 2015, 9).

The most important problem of our age is the environmental destruction. As the IP mission is catalyzing the commercialization of new technologies, it can be aggressive for nature. Therefore, one of the most difficult tasks for architects is overcoming ecological obstacles. A part of this question can be answered by engineering and new clean technologies. But, architectural design also offers some solutions. One of these solutions is placing IPs which has deal with nature research and protection, nearby valuable natural resources in order to monitor their changes and take protective measures. Another solution is fixing the constant green zones which are not changed during architectural development. National parks, nature reserves, ordinary urban green zones, forests and so on must be considered as red points of a development plan. This approach changes the proportion of non-constructed territories to under construction zones. On the other hand, an IP proposes the new solutions of sustainable architectural and urban design. According to Braun Sustainability in this sense can be illustrated here only by few examples: The above mentioned economical use of space helps to save building costs, building material, running costs and – if employed correctly– potentially improves working and corporate culture (Braun, 2005, 30).

It is worth to remind that the main aggressors of an IP for the environment are the production and the scientific research functional groups. Therefore, it is necessary to organize them with strict rules. Today, new technologies of engineering help us to avoid pollution through filters, collectors, smart monitoring systems, etc. But the mission of architecture is reducing expenses by natural methods. There are some rules and regulations for pollution limitation in every country. One of these rules is the classification of buildings by step of pollution producing. This mainly concerns factories and research buildings. The presence of chemical, nuclear, and biological dangers determines the category of a building. Thus there are buildings of some classes, for example, according to Russia rules (Sanitary protection zones and sanitary classification of enterprises, structures, and other objects 2.2.1-2.1.1.1200-03), there are 5 classes. The first class is the most dangerous and the fifth is safe. There is a particular radius of distance from settlement zones. A necessary distance of classes from settlements are:

- Class I: 1000 meter;
- Class II: 500 m;
- Class III: 300 m;
- Class IV: 100 m;
- Class V: 50 m.

These norms differ in every country.

When the speech is about environmental pollution, determining factors are the direction of the prevailing winds, water flows, and altitudes. IPs with a high level of pollution processes should not be built in the direction of flows and the prevailing winds blowing towards settlements and ecosystems of wildlife. In this respect, the altitudes can be used as a barrier surrounding the source of pollution. This solution also helps to avoid the fire spread in catastrophic cases. There are some recommendations about the organization of building fronts regarding winds and settlements. Pollution source buildings must be built perpendicular to settlements to decrease the front area of pollution directing to inhabitation zones. As a building can stop winds it is useful to build IP buildings parallel to the

direction of the winds with a deviation of no more than 45 degrees (Kim, 1979, 36) (Fig.1). If there are several buildings with production and research processes, it is necessary to organize them in a checker pattern. It helps to imprison wind in IP's territory, which helps not only to avoid the pollution of settlements but also to improve the ventilation of IP's territory. It is also necessary to allocate smaller buildings at the first step of confrontation of prevailing winds. Thereby, the natural ventilation of the IP complex is provided (Sysoeva, 2005, 48-53) (Fig.2).

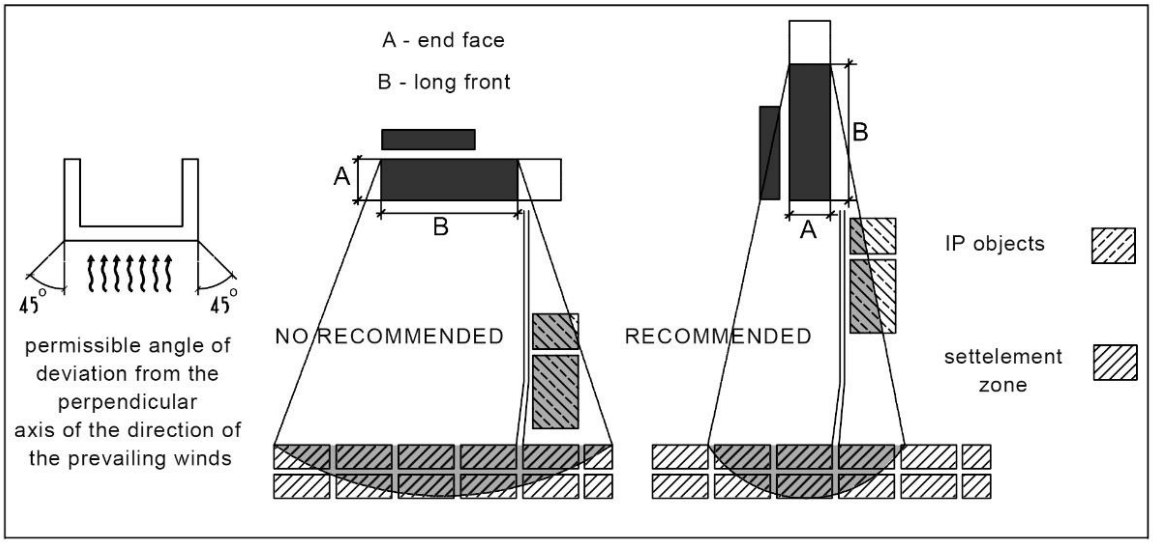

Fig. 1. Organization of production and research buildings' fronts considering the direction of prevailing winds. Source: (Kim, 1976, p. 36).

Another point of pollution control is the functional organization's rationality. In this respect, functional units of these groups (production and research) should be separated as modules. This way it will be possible to control each unit independently.

Since the production process consists of 3 main stages: storage and supply of raw materials; treatment; the release and storage of the product, workshops, each building and structure associated with each stage can be considered as an independent unit (of course in some exceptional cases technical solutions require combining elements of two or all stages into one whole). Depending on the topographic features and shape of the site, as well as to implement a more compact planning solution, it is possible to have different configurations of a production group: linear; parallel; U- and L-shaped; complex (Fig.3). The linear layout is preferable, as it is both practically and psychologically more rational. A parallel solution is a kind of linear solution and is used when there is more than one production conveyor line. The U-shaped layout is appropriate for cases where approaching the warehouses of raw materials and products are necessary. Sometimes part of the unusable product is returned to the production line, but in this case, an additional building or storage facility for returnable materials is required. The L-shaped solution makes it possible to separate the entry and exit of the production area, i.e., for transporting raw materials on one side, and for exporting the product perpendicular to it. Naturally not any particular combination can be recommended for all cases, but the priority of compactness, separateness, and straightness should be observed as much as possible.

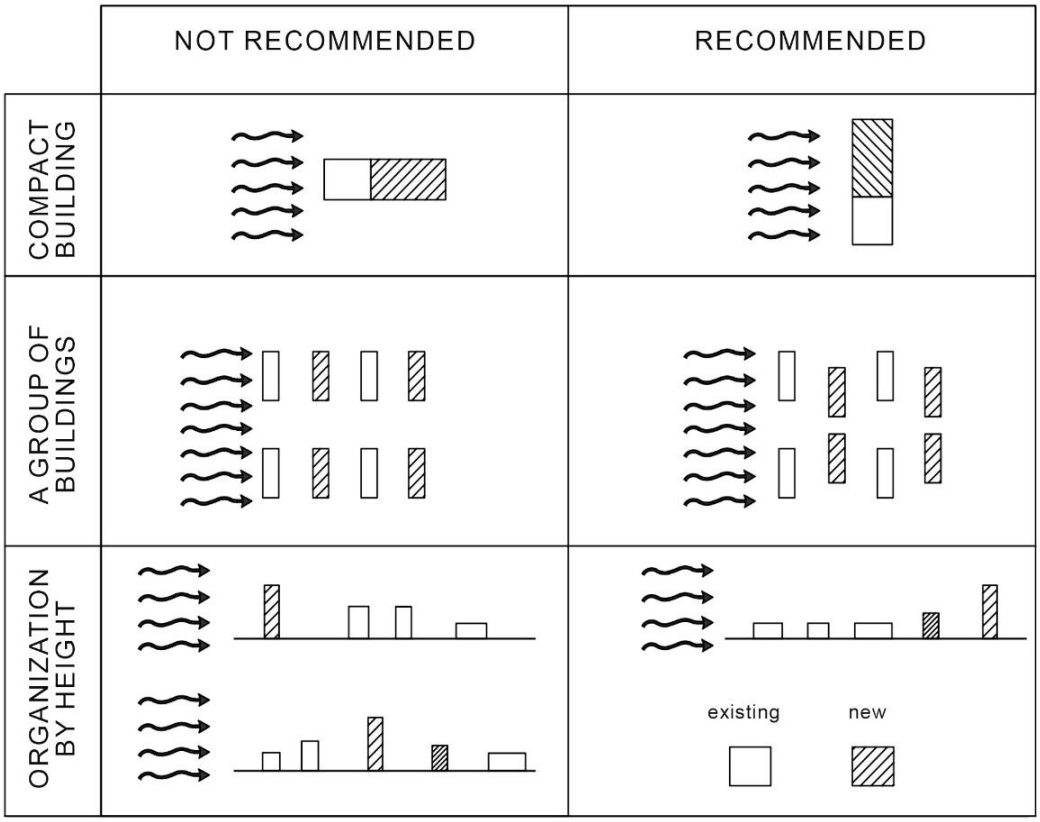

Fig. 2. Recommendation for IP buildings' configuration to imprison winds. Source: Sysoeva, 2005, p. 53

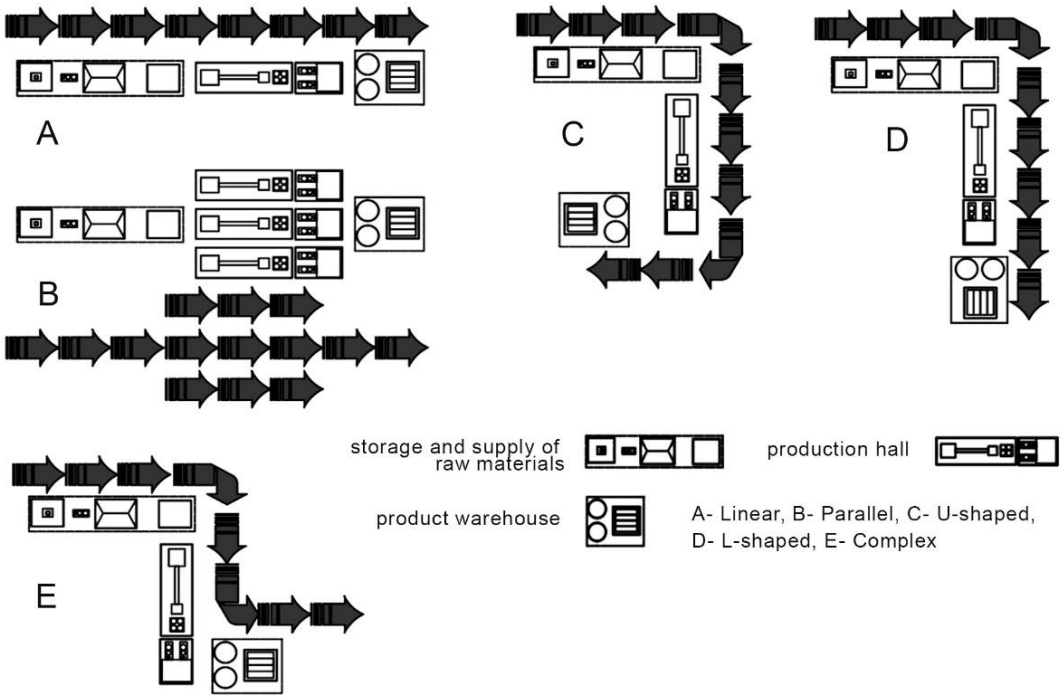

Fig. 3. techniques for assembling the main constituent units of a production group. Source: by author

During the construction of production facilities, transport roads must be organized strictly in straight directions and to avoid fractures, twists, and bends. To achieve this goal, it is recommended to build buildings in one direction along the X or Y axis, and also maintain the same distance from the contour of internal transport roads. This distance must be at least 5 m. To avoid height differences, we need to be able to build production units on the same level. It means that functional units must be allocated along contour lines of the topographic map and not to cross them. This solution helps to avoid waste of energy and system leaks. However, in some cases where the material transfer or resource allocation using Earth's gravity is required, the height difference can be useful. The construction of production and research buildings must be regulated following the sequence and the possibility of expanding every unit. In the process of construction sequence planning, engineering cores and networks between units should be minimized, which is possible by construction site reduction design of cement plants. It is recommended to design rectangular buildings for these functional groups to save energy and keep the rationality of processes (Neginskiy, 1965, 74) (Fig.4).

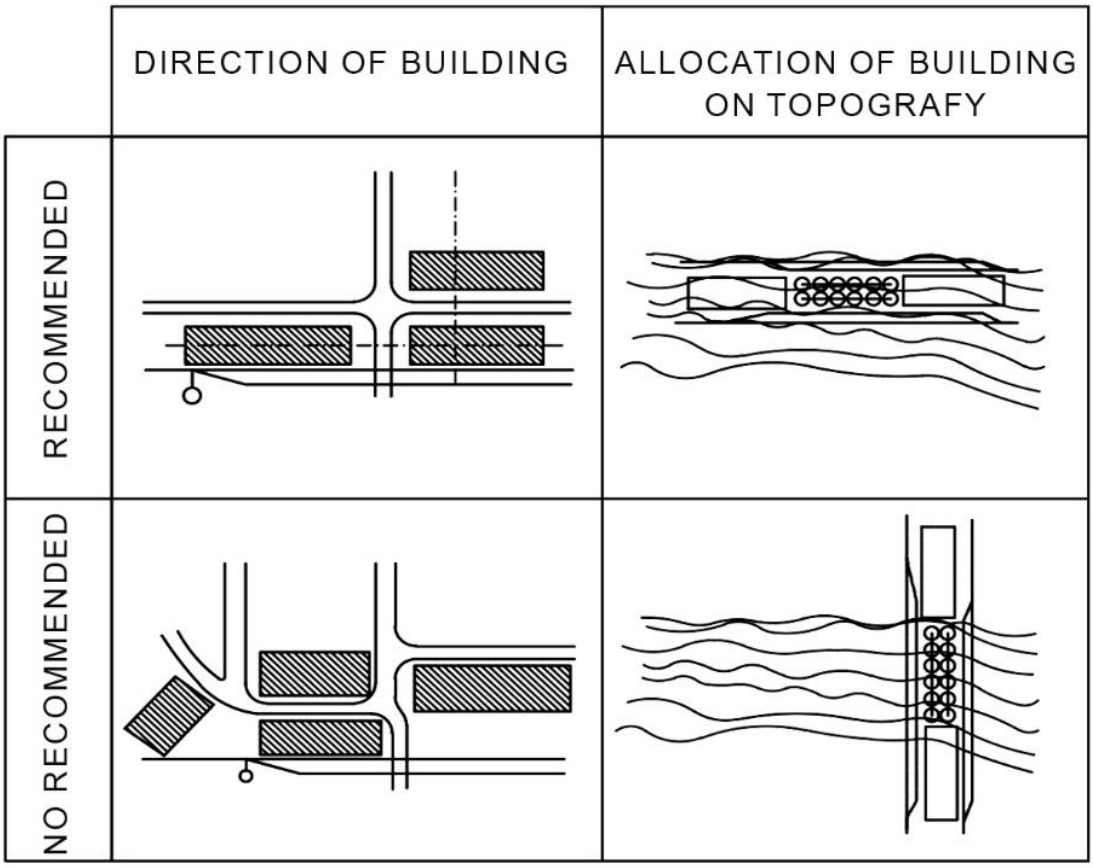

Fig.4. construction of product buildings according to Neginskiy's recommendations. Source: (Neginskiy, 1964, 74).

Technical and technological factors can be divided into general and special. General factors affect the design of offices, and special ones the formation of technological spaces. Type of technology and equipment determines the dimensions of the required space, as well as the shape of the building and the premises in which the processes take place. Sometimes part of the equipment is located outside the building in the form of a separate or adjacent structure (for example, air and vacuum tunnels). Heavy equipment requires a powerful structure, and sometimes is located on the under-

ground floor. To structure the architectural design of IP's buildings and functional zones and also provide future expansions and transformations it is useful to applicate modular regulations.

Since the territorial restrictions affect the size and type of the architectural formation of IP, defining the volume-spatial solution schemes helps to place their elements rationally. Thus, according to existing urban planning conditions, suitable pre-established standard schemes can be used.

From the architectural point of view, an IP can be a multifunctional building, a complex or a town. Functionally, a basic IP consists of offices, laboratories, training facilities, workshops and production halls. Nevertheless, the new conceptions of twenty-one century includes also recreational and cultural spaces for IPs. On the other hand, IPs depend on professionals and specialists, so they should not be allocated far from residential zones and they often includes permanent and temporary residential spaces, blocks and districts. From the point of view of territorial size, Science Parks are classified into four groups: small, medium, large and giant (IASP, 2006-2007), based on which urban and architectural design are formed. Potentially smaller IPs can develop and create the larger ones. Their territorial size varies from one to more than 100 hectares. Structurally they can be in form of a building, a complex, a town, a city or a region (Technopoles) (Fig.5).

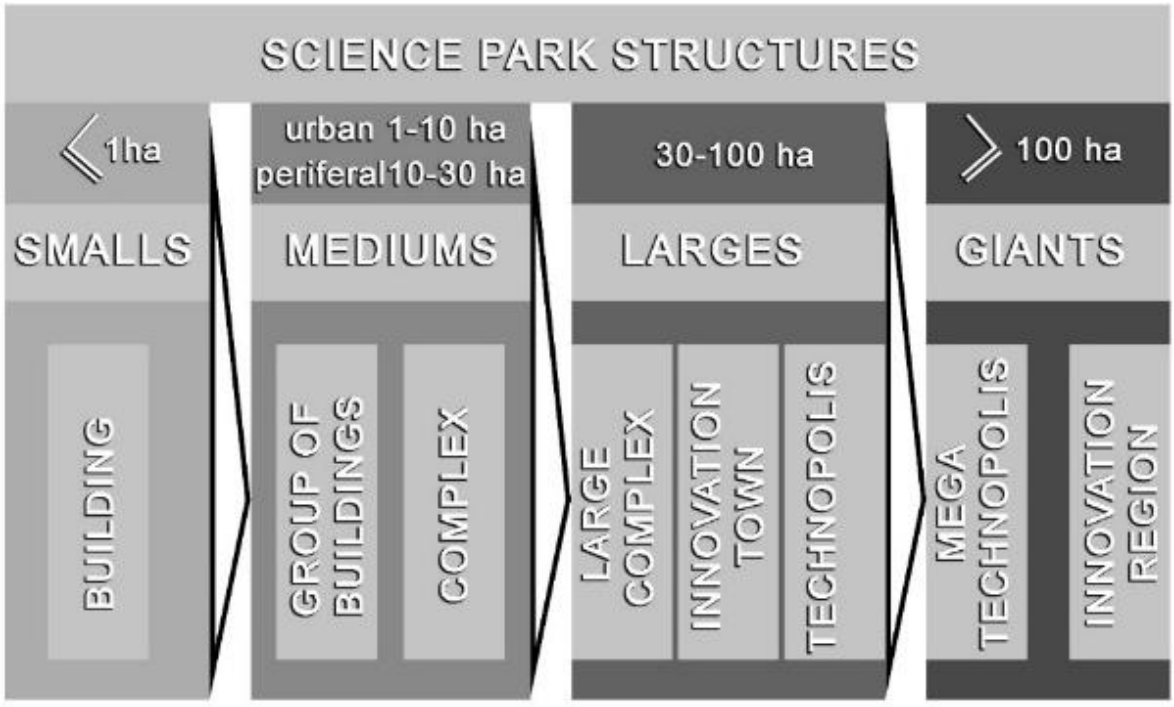

Fig. 5. Forms of IP depends on territorial size and structure. Source: by author

3. IP'S CHARACTERISTICS BASED ON TERRITORIAL SIZE

According to Birch, IPs typically take four key forms: campus expansion (including technology parks), corridor/highway developments, downtown redevelopments and scattered-site projects (Birch, 2015, 27). As the downtown areas are densely built up, the size of an urban IP is limited. As a rule, peripheral areas of a city are convenient to form the larger IPs, because they have non-constructed territories and at the same time access to urban infrastructures. Rumyantsev lists the requirements for the placement of industrial park facilities: the availability of labor and material resources in the selected territory or near it; ensuring the availability of technology park resources

and its infrastructure for any interested parties; organization of a convenient transport network and communication with areas of residence, the presence of settlements on the territory of technopoles; Location in a dynamically developing region, near large families, universities or industrial enterprises; availability of opportunities for further expansion (Rumyantsev, 2006, 46). Further, different types of IPs based on the size will be study in this article.

Territorial size of small IPs is limited to 10'000 m^2. It means that such IP can be a single building or an assemble of main and utility buildings. There is a basic core in every type of IP. This core must consist of a management unit and business incubators. A basis core can create a small IP or in other words a Nuclear IP (Fig.6). Furthermore, it is possible to add some facilities (for example, a canteen and a sport hall) to complexity of this structure.

A distinctive feature of developed IP from the nuclear one is the presence of production and experimental facilities (Lilueva, 2011, 90). Small IPs are mainly urban, which depend on the urban facilities and public services. It's possible to find many examples around the world, but most often they are located in Europe, as often there is not enough space to accommodate large IP in European countries. For instance, the Institute of Physics at the Humboldt University in Berlin, the Adlershof Campus, Berlin, the Max Planck Campus in Tubingen, the IMPIVA Science Park, Castellon, Spain (3200 m^2).

Medium IPs are located in urban structure and peripheral territories of large cities. They are partially or fully independent of urban infrastructure. Their size can vary from 1 to 30 hectare. Max Planck Institute for Biological Infections and German Research Center for Arthritis Berlin, Germany (21 ha), Saitama Prefectural University, Saitama, Japan (10 ha), Building of Biological Sciences, Bundoor West Campus, RMIT University of Melbourne, Australia (1 ha), BIOSTEIN (SYNGENTA) Agrobiological Research Center, Stein, Aarau, Switzerland (1.5 ha), La Rouche, Reno Technology Center, Guyancourt, France (25 ha);

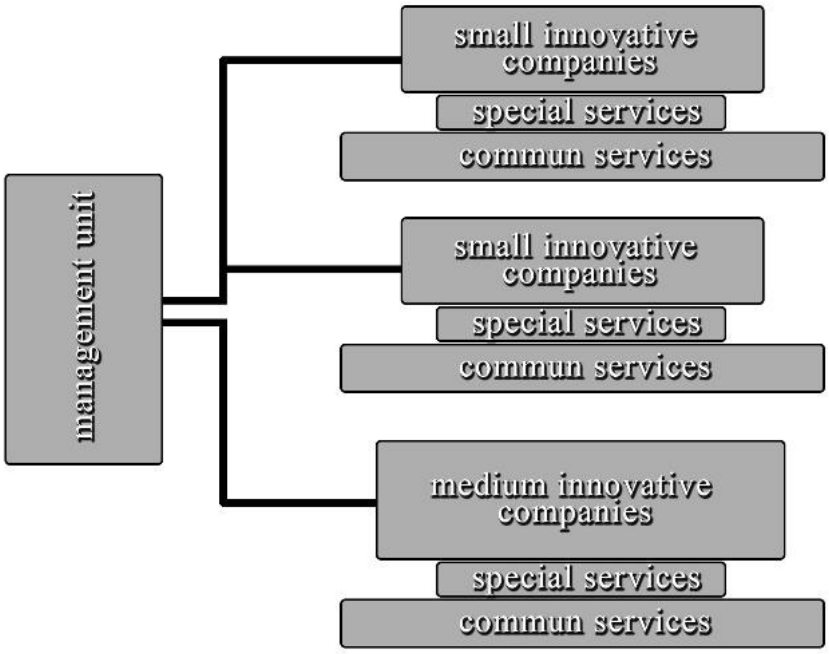

Fig. 6. The scheme of a Nuclear IP. Source: by author

Large IP: from 30 to 100 hectares, mostly peripheral. Yunlong, Digital and Technology Park in China (45 ha), NFU and SZU Advanced Technopark, Nanshan Province, Shenzhen, China (52 ha), Oxford Science Park (52 ha) are examples of this type;

Giant IP: Over 100 hectares -peripheral and non-urban- which are 100% independent. Adlershof Science and Technology Park in Berlin, Germany (420 ha), Antipolis Sofia on the Azure Coast in France (2400 ha) (Lazarev, 2004, 3).

4. ORGANIZATION OF FUNCTIONAL UNITS DEPENDING ON SIZE AND DEVELOPMENT

As it has been mentioned before, some functional groups present in all types of IP. However, in every type, their size and territorial percentage of them differ. Therefore in this part, functional groups of each type are considered.

I. Small IP: the most common small IPs are business incubators with offices and laboratory spaces. Laboratories in such cases can be included in the number of rental premises or be organized in a separate zone. According to analysis of 40 small IPs from world practice, the shares of functional rooms are shown in table1.

Eventually, the average percentage of the total composition of the TS should be determined as follows: conference rooms, training units and business incubators 50%, management zone 25% general service unit 20%, landscape component 5% (according to Lilueva, 2011, 86: 56%, 24%, 16%, 2%) (Fig. 7).

- *Management and administrative unit:* consists of office premises - offices of directors and their deputies, premises for staffs, accounting office, meeting rooms and teaching rooms.
- *Social service unit*: these facilities should be divided into spaces for outdoor activities and sanitary rooms. Due to space limits, the first group often is absent in this type of IPs, although small IPs can be integrated in other forms of IP and in this case, the facilities of outdoor activities are assigned for a group of buildings. This group has a playroom (for example, a billiard room) and / or play or sports grounds near the building. The second group includes technical rooms (boiler room, laundry, etc.) sanitary facilities, cafes, refreshments, canteens or dining rooms, lounges, warehouses, storage rooms for equipment and latrines.

Table 1. The shares of functional rooms in small IPs. Source: by author

Kind of enterprise		Social services	admin-istration	incu-bators	Re-search & produc-tion	training	Spe-cial ser-vices
Innovation centers		+	+	-	+	+	+
		18%	8-10%	0%	50-58%	8-12%	8%
Business incubators (nuclear IP)		+	+	+	+/-	+/-	+
		29%	1%	50-69%	0-1%	0-10%	3%
Multifunc-tional IPs with an emphasis on:		+	+	+	+	+	+
	Com-merce	19%	3-5%	54%	15%	1-5%	6-8%
	Industry	23,3%	1,3%	7%	34,6%	0-5%	34,6%
	Science	20%	2,5%	2,5%	60%	5-10%	5%

- *Special service unit*: universal halls or office premises can be part of this unit. Rental premises are intended for a certain period (3-5 years). Therefore, it is necessary to ensure their maximum planning flexibility so that tenants can change the situation according to their requirements. The innovative potential of the teamwork-based, pluralist, and ever more global re-

search and science sector needs to be backed up by suitable measures – among them the architectural design – that foster flexibility and competition (Braun, 2005, 35).

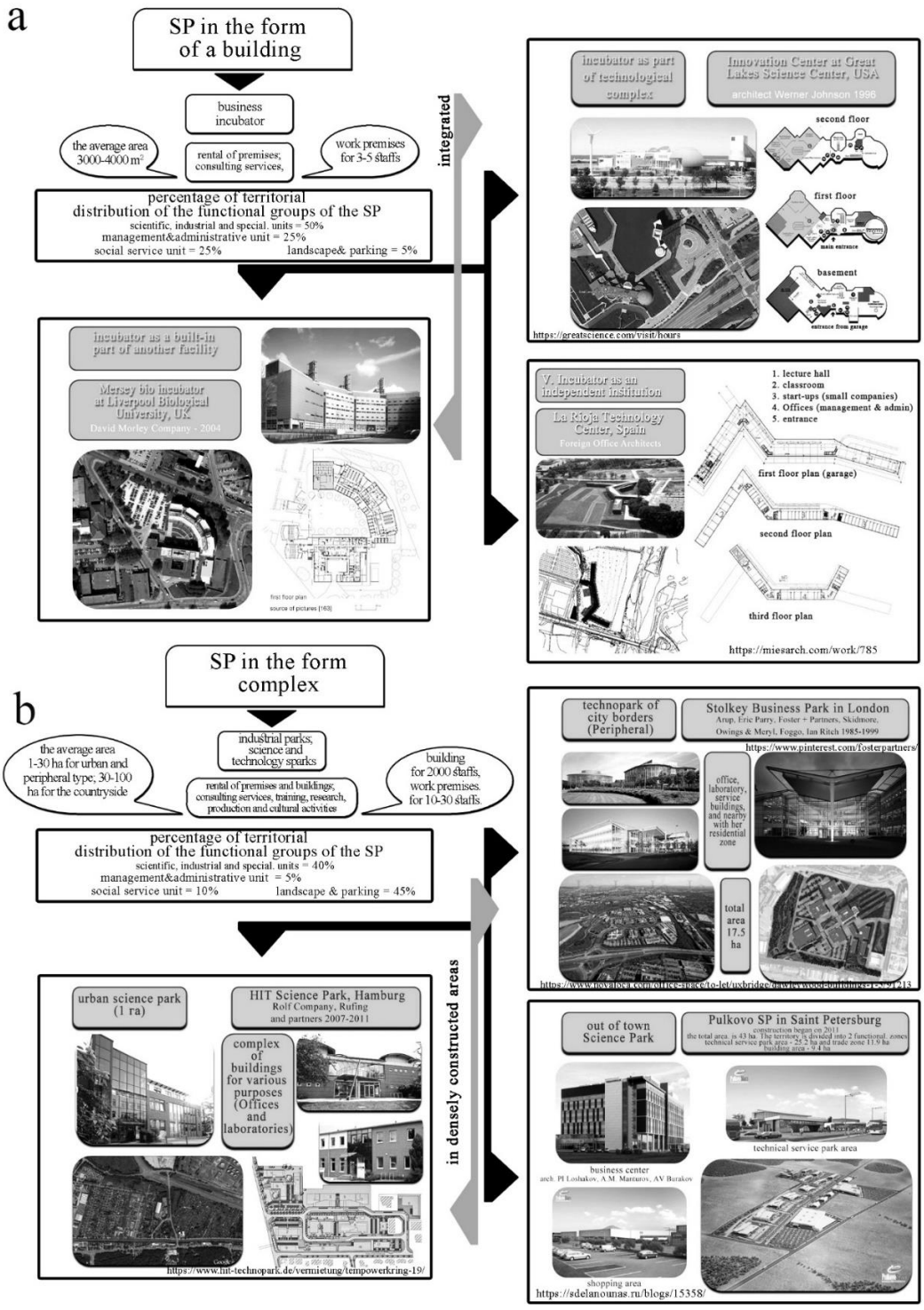

Fig. 7. Analysis of the IP's functional units in the form of a building and a complex. Source: by author

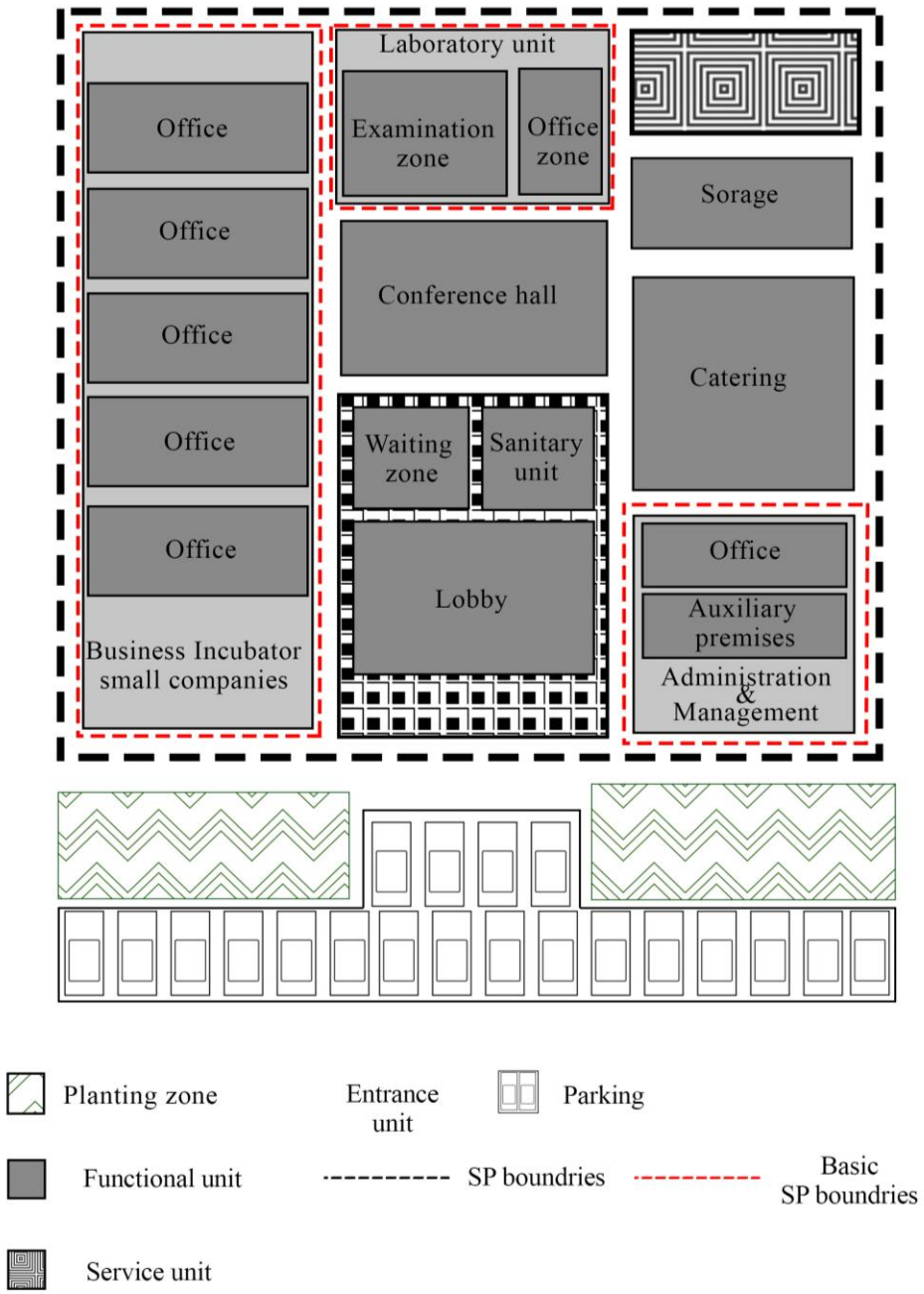

Fig. 8. Schematic proposition for a small IP. Source: by author

II. Medium and large IPs are complexes, blocks, districts and towns, which are specialized (innovation centers), or have two fields of activity (science and technology parks), that means the presence of science and production zones. Nevertheless, often they have one area of activity (business parks), where there are only three main zones of a nuclear IP.

The components of such IPs are buildings. These buildings can be, as well as single, also connected by bridges. The average area of complexes is 1-30 ha for urban types (medium IP) and 30-

100 ha for peripheral blocks and extra-urban towns (large IP). Typically, rental spaces in complex IP for medium-sized firms are 600-2000 m^2. On average, they have functional buildings for 2,000 employees with workrooms and units for 10-30 staffs (Lilueva, 2011, 90).

A distinctive feature of large IPs compared to mediums is the presence of independent large companies. Even though, these companies are independent their presence in the large IPs' territory is conditioned by proximity to source of science and technology. On the other hand, they can use infrastructure and facilities of Park. In addition, the residential area in medium IPs is limited to integrated unit of temporary residence, while in large IPs residential blocks and separate buildings of temporary residence (hotels and hostels) exist (Fig. 9 and 10).

In a medium IP, special service, science and production units together occupy 40%, the management unit 5%, the general service unit 10%, and landscape areas (Including sanitary planting zones, pedestrian and car roads, reserve territory and temporary residential area) 45% of territory (according to Lilueva, 2011, 91: 43%, 15%, 7%, 32%). Even though, comparing with small IP, the scale of functional units is larger, but their percentage decreases due to an increase in the landscape area. It is necessary to include reserve areas for future expansions. These areas can be planted until next construction (Fig. 7).

*Management and administrative uni*t is a multi-functional business building. It houses offices for employees and directors, the finance and accounts department, printing-house, the clerk office and the business consulting premises for the companies.

Social Services Unit: This unit includes garages, parking lots, helipads, temporary residence buildings (hostel with full consumer services for young employees and trainees- hotels), a sport and leisure center, warehouses, transportation support center, technical service buildings and structures (boiler rooms, electromechanical, autonomous power stations, gas compressor stations, water intakes, pumping stations, drinking water treatment plants, waste treatment plants, local treatment facilities, fire stations, security systems and cell phone service provider) and medical center.

Special Service Unit: In these complexes, the companies are organized in single units, but medium companies are preferably located in separate buildings from buildings for small ones.

Rental spaces are organized as follows: buildings for the joint placement of several homogeneous companies, blocked buildings, consisting of individual sections, universal buildings that are designed to organize rental spaces.

In addition, it is necessary to have an exhibition hall or exhibition building, a conference center, an education and training center (with lecture halls, workshops and classrooms), a library and a media library (rarely in the form of a building, but rather, as an integrated part of the administrative or training building).

Science and production unit: This unit includes laboratory buildings, Safe small or pilot production (sometimes both), examination spaces in the form of integrated halls or independent buildings and structures, design bureaus, a technical and warehouses. Since most of the SPs in the form of a complex are multidisciplinary (i.e., in addition to the basic units, there are units of science and production), sometimes they include specialized buildings. On this basis, buildings of complex IP are divided into:

- Specialized buildings, including office, laboratory, production and experimental facilities;
- Integrated buildings, which include office-production, office-laboratory, office-laboratory-experimental premises;
- Universal buildings, in which all of the above premises are located in the same building with hall rooms and the possibility of zoning with partitions.

In medium SPs, it is possible to organize a safe manufacture in a separate building if territory limits allow. It means that the large site to create an expanded sanitary zone is not necessary.

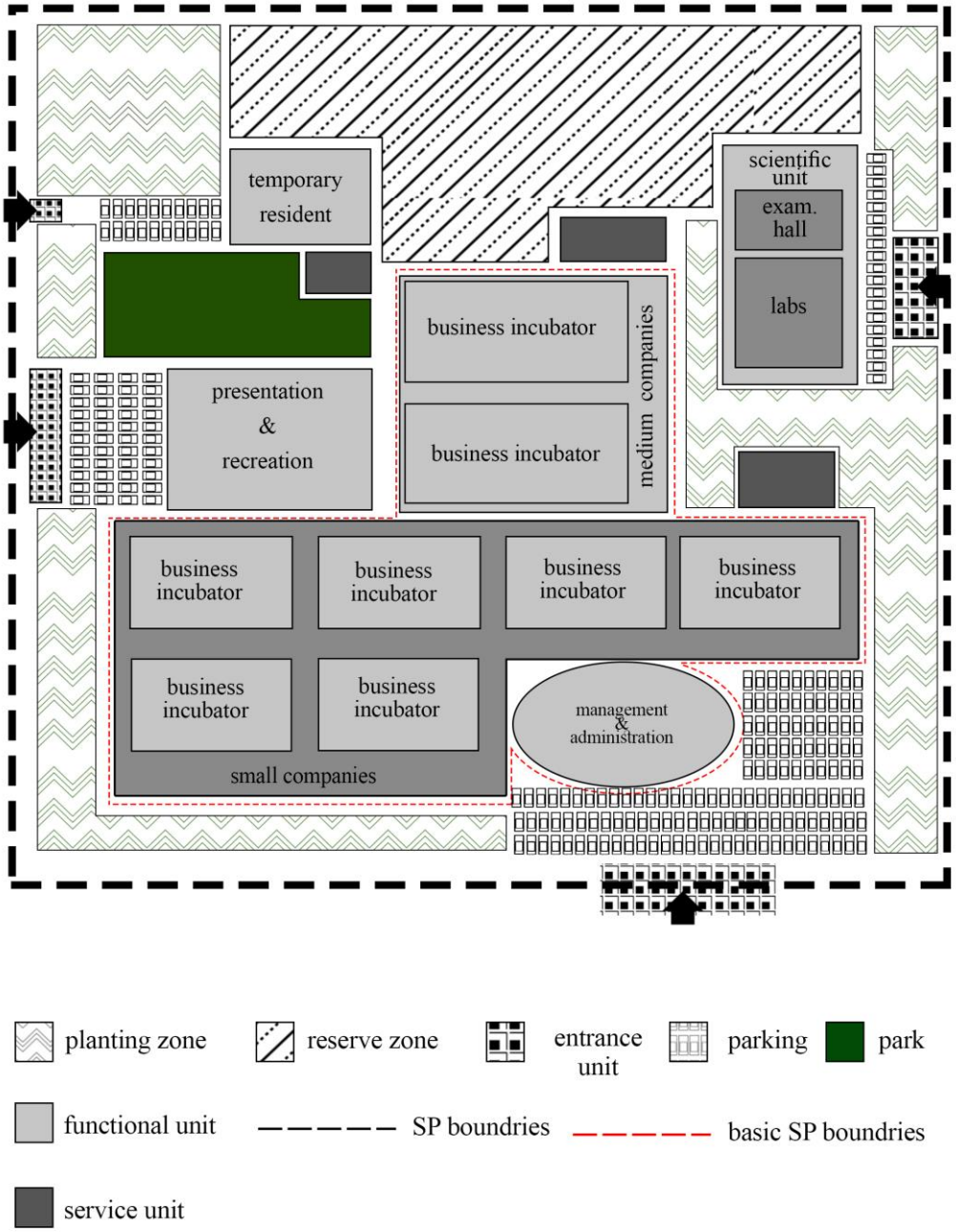

Fig. 9. Schematic proposition for a medium IP. Source: by author

III. Giant IPs are in the form of Technopoles. This type of organization requires the selection of plots with an area of over 100 hectares. They may include buildings, complexes, and quarters. Their territorial distribution is diverse, therefore it is not possible to determine a clear percentage of the area they occupy. Technopoles create a form of territorial polarization within a wider geographical space. It thus provides an interface between productive relationships based on proximity and a broader global perspective and a stimulus for dynamic development (Plan and manage a science park in the Mediterranean, 2011, 5). As an example, the experience of Silicon Valley shows the possibilities of a giant scale urban development at the result of innovation progresses of science and technology, although the formation of Silicon Valley had not been planned in advanced and

this experience led to a chaotic urban development. So a systematic urban design is necessary to optimize the efficiency of innovative cities. One of the most famous IPs of Silicon Valley is the Stanford University's one with 280 ha of territorial size (Rykov, 2010).

Developing and integrating existing large SPs can form Technopoles, as well as through the development of special projects. As an example (for instance), the experience of Silicon Valley shows the possibilities of the urban development at the result of innovation progresses of science and technology, although the formation of Silicon Valley had not been planned in advanced and this experience led to a chaotic urban development. So, a systematic urban design is necessary to optimize the efficiency of innovative cities.

- Management and administrative group includes management complexes, universities, service centers, congress-conference centers, and centers of international relations.
- A Group of special services, science and production (group) can be combined as multifunctional complexes. Technopoles includes exhibition centers, libraries and media libraries, business incubators, technology parks and technology centers, R&B and research institutions, pilot plants, universities and institutes.
- Social Services group includes autonomous energy stations, facilities for waste processing, boiler houses, pumping stations, water intakes, transportation facilities, schools, kindergartens, sports and recreation facilities, public catering establishments, social and public services institutions, residential buildings (Fig.11).

5. CONCLUSION

Innovation Parks are various in dependence on the field of their activity: Innovation Center, Industrial Hotel, Industrial Park, Business Park, Eco Park, Science and Technology Park, and Bio Park. An Innovation Center has the minimum composition for an IP and consists of business incubators. There are several factors influencing on IP's formation, such as Socio-economic, urban planning, natural & climatic, sanitary & hygienic, technical, and operational factors. Socio-economic factors should be divided into two groups: human source organization factors; monetary and non-monetary funds. Urban factors are concentrated on existence of infrastructure and non-occupied territories. As in the peripheral areas the infrastructure is developed and it is possible to find large non-occupied sites, they are the best places to locate IPs. Sanitary & hygienic factors depend on industrial and research enterprises' organization, which means the green zones and effective distance between these enterprises and other urban zones. Technical and technological factors affect the architectural design and the location of functional areas in the IP. In this sense, the application of modular regulation is recommended to provide structural future expansions and transformations of IPs.

An IP can be formed in several ways: integration, reconstruction, association, completely designing in advance. The business incubators can be integrated in campuses and gradually convert them to university based IPs. Industrial enterprises can be reconstructed to IPs. Some innovative enterprises (institutes, research centers, fabrics, business centers) which are concentrated in a place, associate and form an IP. An IP can also be constructed in a non urban territory.

The first step after social and economic evaluation of IP's design location is categorizing its type based on size, location and structure. There is a hierarchy for IP's size: small, medium, large and giant. Since the structure of an IP follows its size, there is also a structural hierarchy: building, complex, district, town, Technopole, region of innovation. The determination of IPs' functional group proportion is necessary for standardizing their architectural design. To form an IP, it is necessary to have a basic core which consists of a management & administrative unit, business incubators, and some social and special facilities. The special facilities are the first step promises of common ware (conference halls, amphitheater). The secondary facilities of common ware (café, restaurant, sport hall, library, exhibition, recreating spaces and so on) create the social group. To specialize an IP, it is necessary to add other units that means the science and production units. The new trend of IPs' formation is their cultural activities. The idea is creating non-formal communicative spaces for specialists in a recreation context. Clubs, restaurants, golf courts, foyer of thea-

ters, exhibitions and so on are good places for such meetings. This approach can also attract the population in order to resident around canons of science and technology. Therefore, automatically the human source, jobs, and new ideas promote stimulus for economy. Gradually, traditional urban structure transforms to a modern environment.

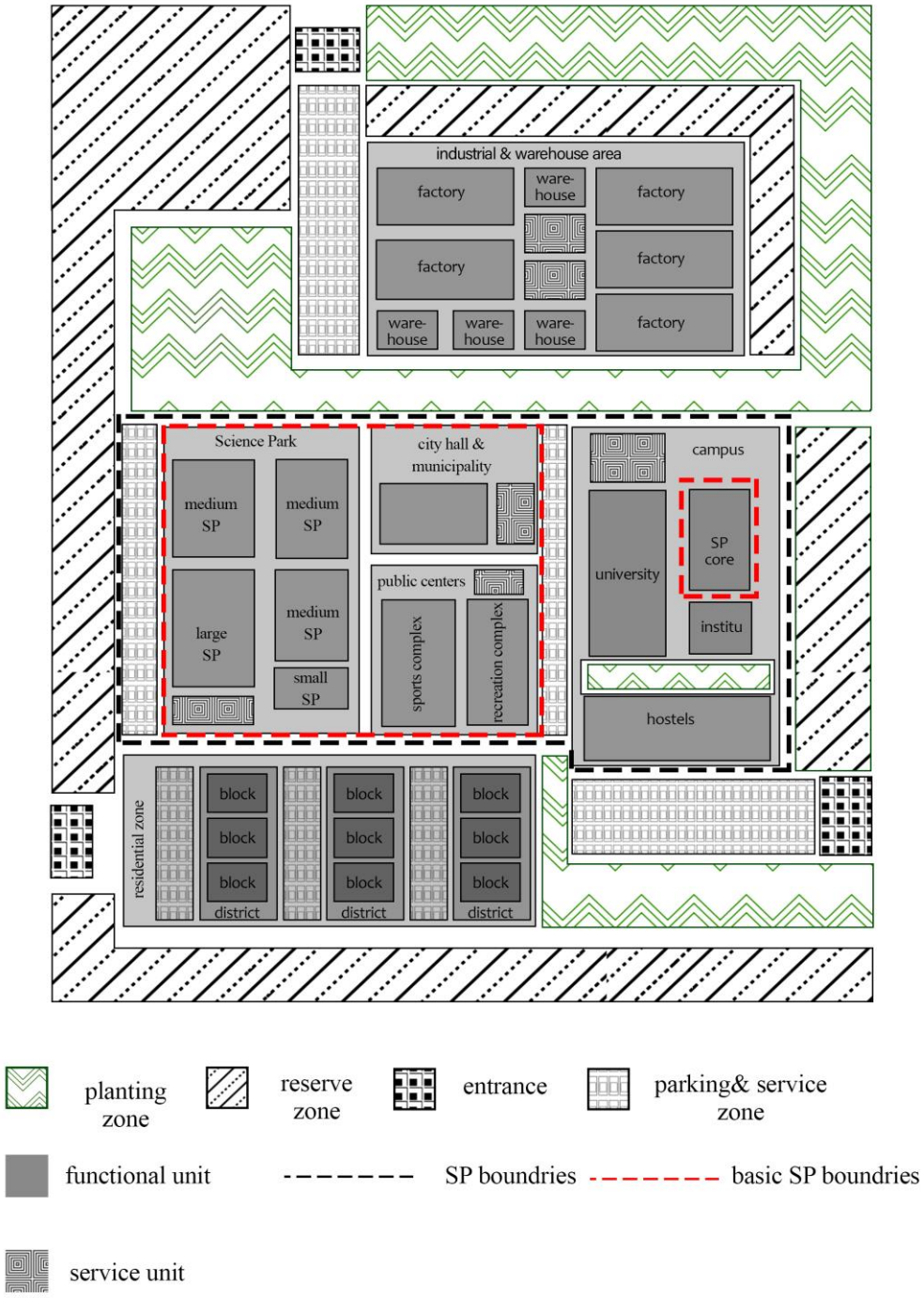

Fig. 11. Schematic proposition for a giant IP. Source: by author

BIBLIOGRAPHY

Birch Eugenie L. / Nussdorf Lawrence C. From science parks to innovation districts, research facility development in legacy cities on the northeast corridor / E. L. Birch — Pennsylvania, PennIUR, 2015. — 31 p.

Braun Hardo / Grömling Dieter, Birkhäuser, Research and Technology Buildings. Publishers for Architecture. Basel, Berlin & Boston, 2005. 235p.

Eumiesaward: https://miesarch.com/work/785. access 2016-05-02

Fosterpartners: https://www.pinterest.com/fosterpartners/. access 2015-02-20 – 2017-12-29

Greatscience: https://greatscience.com/visit/hours. access 2013-12-12

Khrustalyov D.A. Arhitekturnaya organizatsiya zdaniy dlya riskovyih napravleniy issledovaniy v innovatsionnyih parkah velikobritanii. Architectural organization of buildings for high risk researches in United Kingdom's Science Parks. Moscow, AMIT 4 (13) 2010, 15 p. (In Russian)

Kim, N.N. Promyishlennaya arhitektura Industrial architecture. Stroyizdat. Стройиздат, Moscow, 1979. — 175 p. (In Russian)

Lazarev, V.S., Demeschik T.A. Istoriya i zarubezhnyiy opyit sozdaniya i deyatelnosti tehnoparkov i biznes inkubatorov (innovatsionnyih tsentrov) History of foreign experience in the creation and activities of Science Parks and business incubators (innovation centers).State Committee of Science and Technology. Minsk, 2004. 15 p. (In Russian)

Libermann C. Pôles technologiques et nouvelle conception de l'espace industriel. Technological poles and new design of industrial space, for obtaining the grade of doctor in science, École Polytechnique Fédérale de Lausanne, 1994, P. 1-36. (In French)

Lilueva O.V. Arhitekturnoe formirovanije tehnoparkov na baze naukogorodov. Architectural formation of Technoparks based on Science Cities, a PhD thesis, Nijni Novgorad, 2011. — P. 64-109. (In Russian)

Lyashenko, E.A. Metodologicheskie podhodyi k ponyatiyu «tehnoparkovaya struktura» Methodological approaches to the concept of "Science Park structure". Upravlenets. Управленец. № 5/45. Ekaterinburg, 2013. P. 17-22. (In Russian)

Neginskiy M.S. Osnovyi proektirovaniya tsementnyih zavodov Basics of designing cement plants. Promstroyizdat. ПромСтройиздат, Moscow, 1965. 320 p. (In Russian)

NOVALOCA https://www.novaloca.com/office-space/to-let/uxbridge/dawleywood-buildings-1-5/91213. access 2017-05-09

Plan and manage a science park in the Mediterranean, Guidebook for decision makers. —European Investment Bank — Dictus Publishing, 2011, P. 4-65

Rumyantsev AA, Arhitekturnoe formirovanije nauchno-proijzvodstvennyh zdanij innovacionnogo napravlenija. Architectural organization of innovative process in science parks, PhD thesis, Ekaterinburg, 2006. - P. 4-123 (In Russian)

Rykov K. N. Osobennosti arhitekturnoi organizatcii structur tehnoparkov. Features of the architectural organization of Science Parks' structures - "Architecton: news of universities" № 31 2010. — 12 p. (In Russian)

Saveliev, B.A. / Belyavsky, Bocharov, Yu.P., A.V., Gogulan M.F., Karpis E.E., Levenshtein A.A., Metaniev D.A., Platonov Yu.P., Shchusev M.A., Frezinskaya N.R., Nauchni centr modeli razvitija. Scientific center, models of development, Nauka (Наука), Moscow, 1979. — 109 p. (In Russian)

SDELANOUNAS https://sdelanounas.ru/blogs/15358/.access 2012-03-22

Sysoeva O.I. Rekonstrukcija promyshlennyh ob'ektov. Reconstruction of industrial facilities, BNTU (БНТУ), Minsk, 2005. - 136 p. (In Russian)

TEMPOWERKRING https://www.hit-technopark.de/vermietung/tempowerkring-19/. access 2014-12-05

Yezhov V.I. Arhitektura obshestvennih zdanija I kompleksov The architecture of public buildings and complexes, VISNIK. ВИСНИК, Kiev, 2006. - P. 13-41. (In Russian)

AUTHOR’S NOTE

Kazemi Lary Gholamali, architect, candidate of architecture of urban buildings and structures’ Department, Kyiv National University of Construction and Architecture, Kyiv, Povitroflotsky Avenue, 31, 03680. The main area of research: Fundamentals of architectural planning organization of research and production objects of Innovation Parks.

Kontakt | Contact: alikazemilari@gmail.com